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LONGITUDES OF SOME OF THE PRINCIPAL PLACES IN CANADA, *by Electric Telegraph.* *By Lieut. E. D. Ashe, R.N., F.R.A.S.*

The introduction of the telegraph wire into an observatory, and the facility and rapidity of registering observations by its means, may be considered one of the most useful adaptations of the age; and I never recollect having been more deeply impressed by the idea of man's intellectual development, than I was when I heard the "relay" in the Observatory, Quebec, beating the seconds of the sidereal clock in the Observatory at Cambridge. I have long ceased to wonder at the snorting locomotive as it dashes past at the rate of forty miles an hour, dragging some hundreds of human beings in its wake. Man can reason, step by step, from the tea kettle until he arrives at the steam engine; but when we hear the pulsations of a clock, be it ever so far off, our reasoning faculties stagger under the stupendous fact. It follows then, as a matter of course, that as the beating of a clock in one observatory can be heard in another, no method can be so accurate for determining the difference of meridians as the mode of doing so by the electric telegraph.

Two fixed observatories being connected by the telegraph wire, there are various modes of determining their difference of meridians. Perhaps the most accurate is to send a signal every time a star of a pre-arranged list passes each wire of their respective transit instrument, and as the time of these signals is carefully noted in each, it follows that the time taken by each star to pass from the meridian of one observatory to that of the other can be most accurately obtained. Care, however, must be taken to change the observers in order to eliminate the personal equation. And if the signal be sent from East to West, and again from West to East, the time occupied by the signal in passing along the line causes the meridianal difference to be too great in one instance and too little in the other, and consequently the mean gives a correct result. For instance, let the observatory A be twenty minutes to the eastward of an observatory B, and suppose the signal to occupy one second in going along the line, then if A sends a signal at 4h. 30m. 10s., if no time is lost, B will receive the signal at 4h. 50m. 10s.; but as we suppose the signal to occupy one second in passing from A to B, B will receive the signal at 4h. 50m. 11s., and the difference of meridians will be 20m. 1s., a second too much. But supposing B to send a signal to A at 4h. 50m. 10s., then A will receive it at 4h. 30m. 11s., and the difference of time will be 19m. 59s., evidently one second too little; but the mean of the results give 20m., the correct difference of longitude. Therefore, by the observers exchanging places, and by sending the signal backward and forward, the greatest accuracy may be obtained.

Lunar and stellar photography may be the means of superseding the laborious and imperfect manner of taking observations with the human eye; and it is to be hoped that the noble example set by the Observatory, Cambridge, U.S., in this respect, may be followed by others, and that we shall ultimately succeed in making the heavenly bodies register their own observations. With respect to stellar photography, so much will depend upon the state and purity of the atmosphere, that but few places are well adapted to this mode of observing, but many say that Quebec has the advantage in this respect over most other places in British America, and I sincerely hope that ere long stellar photography will be taken up by Canada.

Before giving my report on the determination of longitude, I will make a few observations that may be useful to those who may be occupied on a future occasion in determining meridianal distances.

On arriving at the place, just call at the telegraph office and make friends with the department, as without their hearty co-operation it is useless to proceed. Then look out for some rocky ground near to the office, where you can build your observatory. Let the support of your instrument be of stone, and of a height that will enable you to apply and read the level when standing on the ground. This is of great importance, as the level must be applied quickly and often. Also take care to have the screw that moves the instrument in azimuth to your right hand in looking to the northward. If you are left-handed, *vice versâ*. See that the collimation has not been thrown much out by travelling. If it has, correct it as nearly as you can by the middle wire in reversed positions.

As you do not know the longitude of the place within two minutes, and as the rate of your chronometer should not be trusted with its former rate after travelling, you cannot get the instrument into the meridian by bisecting a star with the middle wire,—as the correct time cannot be known by the chronometer, and procuring observations for the correct local time would occupy much time,—I recommend the following way to get a transit instrument quickly into the meridian.

First direct the instrument to a point about a degree and a half from Polaris, in a line joining that star and the fifth star of the Great Bear. This ought to place the transit instrument within half a degree of the meridian; then take from the *Nautical Almanac* two circumpolar stars, that differ about twelve hours in their R.A. For instance, 51 Cephei and δ Ursæ Minoris on March 1st, 1859, had a difference of R.A. of 15m. 58·75s.—51 Cephei passing ***sub. polo.*** first, and it will come into the field of an inverting telescope on the right; before it has passed the second wire of the instrument (if it is not much out of the meridian) by elevating the telescope δ Ursæ Minoris ought to be in the field. If it is not, move the North end of the telescope to the East until it is. When you have got these stars within range of the field, and (as near as you can guess) 51 Cephei 15m. in advance, there will then be sufficient time to adjust the level, which has of course been put out by moving the instrument. Should you have a mean solar chronometer, the difference of R.A. 15m. 58·75s. must be turned into mean time. Now mark the time that 51 Cephei passes the middle wire, and if the transit is in the meridian, δ Ursæ Minoris will come to the middle wire in an opposite direction 15m. 58·75s. after 51 Cephei. Should it not do so, mark its position at the moment that it ***should*** be at the middle wire, and then by turning the azimuthal screw, bring δ Urs. Min. not quite half way towards the middle wire. The distance that the star is to be moved is known by looking at deviation factors. This mode of proceeding is independent of the error of the chronometer; it only supposes that it goes with an even rate for a quarter of an hour, and by one operation it should place the instrument within one second of time of the meridian. You then take observations for the errors of deviations, and proceed at once to get local time.

By looking at my report to Sir William Logan many causes of failure may in future be avoided, and perhaps some trouble saved.

Report to Sir W. E. Logan, F.R.S.

Quebec, 20th January, 1858.

Sir,—In the month of October, 1856, at your request I left Quebec for Montreal, in order to determine by electric telegraph the longitude of that city. On my arrival, the first object was to procure a suitable place, not far from the telegraph wire, and permission was given to make use of the top of the Exchange.

The transit instrument was placed upon a stack of chimneys, and a temporary canvas cover erected to protect the instrument from the wind. On the 28th October the transit instrument was in the meridian, the telegraph wire was led up to the top of the house, and a message sent to Quebec to be ready at 7h. p.m. The night was fine and clear, and we commenced by giving a signal to look out when a star entered the field of the telescope, and as it passed each wire a single dot was sent along the line to Quebec. The assistant, Mr. Heatley, on the signal being given to look out, listened attentively to these dots and to the tick of the sidereal clock, and registered the fraction of a second: by these means the observations at Montreal were noted down with all the ease and facility that could have been attained in a properly fitted observatory instead of the temporary arrangement we had on the top of a house.

From the operators not understanding some technical expressions, and from the novelty of the transaction, many stars were lost; but considering that it was a first trial we had every reason to expect that we should finally succeed.

On the following night we were again connected by the telegraph wire, but after sending a few stars a great disagreement was found to exist between this and the preceding night's work. On my taking observations to determine the errors of the instrument, I found that it had moved considerably out of the meridian; and subsequently I discovered that the passing of a cart, even at the distance of two streets, put the whole chimney in motion: for this there was no remedy, and the idea of succeeding with the present arrangement was hopeless.

Having to return to Quebec, I left on the 2nd November, with the knowledge gained by experience that a transit instrument placed on the top of a house could only give doubtful observations, which were worse than useless.

On the 29th December I left Quebec for Toronto, and on my arrival took up my quarters with my friend Professor Kingston of the Magnetic Observatory. Here there was every convenience, a small transit instrument in position, and a sidereal clock. The observations for time were under the superintendence of Professor Kingston. The distance of the Observatory from the Telegraph Office is, I should think, about two miles, and the work of leading the wire through the town and into the Observatory presented many difficulties: one, the ground being frozen hard could not be opened for sinking the posts, and another, the interference with private property: but by the hearty cooperation of the Superintendent of the Telegraph Office, Mr. Dwight, and by some contrivance, these difficulties were surmounted.

The cloudy state of the atmosphere prevented our working until the 17th of January, which was fair for observations. As our object was to determine the time by the face of our respective clocks at the same instant, thirty dots were sent at intervals of a second in each minute, so that if the clocks were not beating together, the fraction of a second that one clock was after the other might be guessed at. The fraction being known, the second, minute, and hour are sent, and consequently the readings of the two clocks are known at the same moment.

The errors of the clocks were obtained by observations of many stars on the same night, and the errors applied to the respective clocks; the true difference of time between Quebec and Toronto was thus known, and hence the longitude. *See Table.*

On the 5th of February I left Quebec for Kingston, and on my arrival was offered a home and every assistance by Dr. Yates. The site which I selected for the temporary observatory is situated in a cross street between Earl Street and Barrie Street. Two large blocks of limestone were brought and placed in the corner of a yard, and some planks about six feet long were fixed around them, covering in a space about eight feet square. This was also some distance from the Telegraph Office, but by taking advantage of an old fence and of an occasional tree, the wire was brought to the observatory without much difficulty.

My past experience had taught me to avoid the tops of houses, and to select the solid earth and solid rock for the support of my transit instrument. Still, I had another lesson to learn. This neighbourhood was infested with boys, who, when they saw a light shining through the cracks of the boards, commenced throwing stones with a determination and precision worthy of a better cause; and some of the few clear nights that occurred in this month were lost in consequence of boys' love of mischief. I first tried mild entreaties and then severe threatenings; they laughed at the former and made faces at the latter. I then procured the service of the police, who partly succeeded in keeping the boys from further interference with my duties.

On the night of the 20th of February, all being ready, and the weather favourable, we made arrangements for sending signals to Quebec. I found that the method adopted at Montreal, of sending a signal to the Observatory at Quebec each time a star passed the wire of the telescope, involved the necessity of employing a telegraph operator for some hours; but by merely exchanging the time, the operator was not required for a longer period than half an hour; consequently, in this case, we sent thirteen taps, at intervals of twenty seconds, from Kingston to Quebec, from a mean solar chronometer. As a sidereal clock gains one second on the mean solar chronometer in six minutes, Quebec listened for and marked down the second of the sidereal clock which was co-incident with the signal sent from Kingston, and consequently, without any guess-work, had the fraction of a second. Quebec then sent similar signals from the sidereal clock, and Kingston listened for and marked down the seconnd which was co-incident with the signal sent from Quebec; in this way was the difference between the two places ascertained to the hundredth part of a second. I conceive that signals sent from one end of the line by *mean time* and from the other end by *sidereal time* ensure the most satisfactory results. Although the observations for time were not very satisfactory, still, from the severity of the weather, and the nuisance above alluded to, I resolved not to stay any longer for further trials, but left for Montreal on the 30th. On my arrival, I accompanied you, and we reconnoitred in the neighbourhood of Viger Square, where we were glad to find that there appeared to be a scarcity of boys, and those that did heave in sight were perfectly tame. The gardener's tool-house, in Viger Square, appeared well suited to our purpose, and by placing a large block of limestone on a solid basis built beneath it, we had in perfection the principal requisite for the support of a transit instrument—that of fixity.

In order that I might avail myself of every opportunity of taking observations, I took up my residence there, and although great cold was experienced, nevertheless the advantage of being close to my work far more than compensated for the severity of the weather.

The night of the 12th of March was clear, the instrument firmly fixed and well adjusted, and signals were sent to and from Quebec. Although the electric current was weak, and the signals at the Montreal end of the line difficult to be heard, still the results were most satisfactory, and I left on the following morning for Quebec.

Chicago being placed on some charts in a longitude differing by upwards of forty miles from that on another, it was of the greatest consequence, before making a map of Canada, that the right position of Chicago should be ascertained. I therefore, with that view, left Quebec early in the month of April for this renowned city, and on my arrival called on Lieut-Col. Graham, U.S.A., and stated the object of my visit. He offered and gave me his valuable assistance, and obliged me by taking charge of the operations at one end of the line; after an observatory was erected, my transit instrument in position, and the telegraph authorities spoken to, I hurried back to Quebec, and found that they had succeeded on one night in sending signals; but in consequence of the weather not being very favourable at Chicago, we were again in communication on the night of the 15th of May.

The electric current was transmitted via Toledo, Cleveland, Buffalo, Toronto, and Montreal, a distance of 1,210 miles, by one entire connection between the two extreme stations, and without any intermediate repetition, and yet all the signals were heard distinctly at either end of the line; the signal occupied only ·08 of a second in passing along that distance.

On the 24th July I left Quebec for Windsor, and my past experience enabled me soon to select a spot suitable for the transit instrument, around which a covering of boards was put up. On the night of the 15th of August we succeeded in sending signals to Quebec; but unfortunately the sky became cloudy, and I was unable to get satisfactory observations for the local time. However, on the 18th, the signals and observations for time were most complete.

On the 19th I left Windsor for Collingwood, and on my arrival, I found rock and quietness in the yard of Mr. Armstrong's house, where I was stopping. The instrument was in position and the night favourable on the 1st of September, and satisfactory signals were exchanged. I left on the following day for Quebec.

It was now most important that the longitude of Quebec should be determined with the utmost possible accuracy. I had formerly by electric signals on one night from Fredericton, N.B., obtained by the kindness and assistance of Drs. Toldervy and Jack, the position of the Quebec Observatory; but on that night observations for our local time could not be taken, and we had to trust to the observations taken on the previous night and to the good character of the sidereal clock.

If we had been able to get the difference of longitude between Fredericton and Quebec, the position of the Quebec Observatory would have been quite certain, as the longitude of the former had been obtained by frequent signals on many nights with Cambridge, which by interchange of several hundred chronometers with Greenwich, is supposed to have its meridional difference of longitude ascertained with all the accuracy possible short of that to be arrived at by the transatlantic cable.

We were unable to again get telegraphic communication with Fredericton on account of the submerged cable at Cape Rouge being broken; but Professor W. C. Bond, of Cambridge Observatory, offered in the kindest manner possible to send and receive signals to and from Quebec. On the 21st of September and 9th of October, the communications between the Observatories of Cambridge and Quebec were completely successful, and the longitude of Quebec, as well as those places already referred to, finally settled.

The longitude of the Observatory as obtained by telegraphic signals, and the longitude published on the Admiralty charts, differ by no less than fourteen seconds of time, and the other places whose positions have been determined in a similar manner, have a still greater difference.

On the 29th of October I left Quebec for Ottawa, and on my arrival put up at Mr. Doran's boarding-house and went in quest of a site for the transit instrument. On Barrack Hill there were several blocks of limestone, around one of which I built a little observatory, and had the telegraph wire brought there. The night of the 14th of November was beautifully clear, and the result of our night's work most satisfactory.

June 18th, 1858. I left Quebec for Three Rivers, and on my arrival I accepted the kind invitation of Oliver Wells, Esq., to make his house my home, and immediately went in search of a place suitable for fixing the transit instrument. After some time I selected the Barrack Square (then unoccupied) as the spot most suitable for my purpose, as it was close to the Telegraph Office, and was also fenced in; I felt myself secure from the intrusion of boys,—the pest of itinerant astronomers; indeed I had not seen any since my arrival.

As there was no rock in the neighbourhood, nor anything suitable for the support of the instrument on the sandy foundation that exists in the vicinity of Three Rivers, and as a very fine Roman Catholic Cathedral was in the process of erection not far off, I went at once to the Curé and begged a stone, when with that politeness peculiar to the French Canadians he placed everything that he had at my disposal. Availing myself therefore of his kind liberality, I took two, and had them carted to the Barrack Square. Previously to my going in quest of a stone I had spoken to a carpenter, who, on my return, had the stuff cut out ready to board in the transit instrument. The stones were firmly placed, and the telegraph wire by the support of only two posts was brought to the observatory, and all was ready to take advantage of the fine weather to make preliminary observations requisite for getting the instrument into the meridian. I then made up my mind to return home and rest until sunset, when I would again return for my night work. On leaving the Barrack Square, to my great dismay I saw that two palings of the fence were pulled down, leaving a space sufficiently large for a boy to get through. I looked upon it in the same manner that a person in taking a house would look at a rat hole in a cupboard; but as all was quiet and not a leaf stirring, my fears quickly subsided.

A little before sunset I left my friend's house for the observatory; it was a lovely evening; the twittering of swallows took me back to other climes and other days; and as it was rather early I sauntered along with my thoughts wholly absorbed in this world and not in others, when a sound came floating on the air that quickly dispelled my reveries. It was the noise of boys at play. I then was sensibly made aware of the fact that there were boys in and about Three Rivers,—Yes,—and when I came in sight of the Barrack Square I saw it full of boys playing cricket—my feelings may possibly be imagined but they could not be described. I came amongst them just at that part of the game when they had cried "over." Some boys were taking up their positions by jumping like a frog over the backs of all who came in their way, others by rolling like a carriage wheel into the place assigned to them. Kingston and all its annoyances came now to my mind, but I observed that they were a different sort of boy from that of Kingston. The type of the latter may be considered as short, deep-chested, yellow hair, blue eyes, one of which was always winking at a companion, face much freckled, voice loud and shrill, accompanied by a habit of putting the thumb to the nose when spoken to. The type of the former may be considered as tall, dark hair, hazel eye, musical voice, with a habit of paying attention when spoken to. I went up to them and explained the delicate nature of the instruments that were near them, begged that they would not discontinue their manly sport, as I was sure that they would be careful not to do any harm; they promised to do so, and after they had finished the game they went off and never more gave the least annoyance. That night I got the instrument nicely adjusted, and after only one failure succeeded in sending and receiving signals to and from Quebec on July 1st, that gave a most satisfactory result. I left on the 5th for Quebec.

In conclusion I may say that the ease and accuracy with which the position of a place can now be fixed by means of the electric telegraph renders it imperative that all those places which can avail themselves of the use of the telegraph line, should have their longitudes determined at once, in order that a correct map of Canada may be produced.

Subjoined I send you an abstract of the observations made.

I have, &c.,

E. D. ASHE.

Abstract of the Telegraphic Observations determining the Longitudes of several Places in North America, by Lieut. E. D. Ashe, R.N.

Quebec, 21*st September*, 1857.

The place of observation was the Observatory in Mann's Bastion, Citadel.

	h.	m.	s.
By the signals sent from Quebec to Cambridge, the difference of longitude is shown to be	0	0	18·27
And by the signals from Cambridge to Quebec	0	0	18·25
Mean difference of longitude by the work of the 21st September	0	0	18·26
Again on the 9th October:—			
By the signals sent from Quebec to Cambridge	0	0	18·44
By the signals from Cambridge to Quebec	0	0	18·33
Mean difference of longitude by the work of the 9th October	0	0	18·38
Mean of both nights' work:—			
Quebec Observatory West of Cambridge Observatory	0	0	18·32
Longitude of Cambridge West of Greenwich, as communicated by Professor W. C. Bond	4	44	30·70
Longitude of Quebec Observatory	4	44	49·02

Toronto, 21*st January*, 1857.

The place of observation was the Magnetic Observatory.

By the signals sent from Quebec, Toronto is West of Quebec	0	32	44·51
By the signals from Toronto „ „ „	0	32	44·31
Mean difference of longitude	0	32	44·41
Longitude of Quebec	4	44	49·02
Longitude of Toronto Magnetic Observatory	5	17	33·43

Kingston, 28*th February*, 1857.

The place of observation was the new Court House.

By the signals sent from Quebec, Kingston is West of Quebec	0	21	05·60
By the signals from Kingston „ „ „	0	21	05·39
Mean difference of longitude	0	21	05·50
Longitude of Quebec	4	44	49·02
Longitude of Kingston	5	5	54·52

Montreal, 12*th March*, 1857.

The place of observation was in Viger Square, 650 feet West of Captain Bayfield's station on Gate Island.

By the signals sent from Quebec, Montreal is West of Quebec	0	[illegible]	23·01
By the signals sent from Montreal „ „ „	0	9	22·38
Mean difference of longitude	0	9	22·70
Longitude of Quebec	4	44	49·02
Longitude of Montreal	4	54	11·72

Chicago, 15*th May*, 1857.

The place of observation was in the play-ground of the school situated to the northward of the Roman Catholic Church, Huron Street.

	h.	m.	s.
By the signals sent from Quebec, Chicago is West of Quebec..	1	5	41·44
By the signals sent from Chicago „ „ „	1	5	41·60
Mean difference of longitude	1	5	41·52
Longitude of Quebec	4	44	49·02
Longitude of Chicago	5	50	30·54

Windsor, 18*th August*, 1857.

The place of observation was in the yard of Mr. Sholand in Goyeau Street, about fifty yards to the westward of the new English Church, and twenty yards to the westward of the Court House.

By the signals sent from Quebec, Windsor is West of Quebec..	0	47	19·04
By the signals sent from Windsor „ „ „	0	47	18·97
Mean difference of longitude	0	47	19·00
Longitude of Quebec	4	44	49 02
Longitude of Windsor	5	32	08·02

Collingwood 1*st September*, 1857.

The place of observation was the Railway terminus.

By the signals sent from Quebec, Collingwood is West of Quebec	0	36	01·43
By the signals sent from Colingwood „ „ „	0	36	01·59
Mean difference of longitude	0	36	01·51
Longitude of Quebec	4	44	49·02
Longitude of Collingwood	5	20	50·53

Ottawa, 14*th November*, 1857.

The place of observation was 120 yards East of the Flag-staff on Barrack Hill.

By the signals sent from Quebec, Ottawa is West of Quebec..	0	17	59·24
By the signals sent from Ottawa „ „ „	0	17	59·30
Mean difference of longitude	0	17	59·27
Longitude of Quebec	4	44	49·02
Longitude of Ottawa	5	2	48·29

Three Rivers, 1*st July*, 1858.

Place of observation at Three Rivers was in the Barrack Square, due South of old French Church.

By signals sent from Quebec, Three Rivers is West of Quebec.	0	5	20·14
By signals sent from Three Rivers „ „ „	0	5	20·18
Mean difference of longitude	0	5	20·16
Longitude of Quebec	4	44	49·02
Longitude of Three Rivers	4	50	09·18

Note.—It may be interesting to compare the longitudes as determined by Lieut. Ashe with the values previously assigned to them.

	h.	m.	s.
Quebec, former value	4	45	04
„ Ashe	4	44	49·02
Toronto Observatory, by M. C. Stars in 1840	5	17	19
„ by Chronometer with Boston	5	17	33
„ Mean of above, formerly adopted	5	17	26
„ Ashe	5	17	33·43
Kingston, usual value	5	06	40
„ Professor Williamson, 1854	5	06	08·48
„ Ashe	5	05	54·52
Chicago, usual value	5	50	20
„ Ashe	5	50	30·54

CARPENTARIA TO BATAVIA, KOEPANG, SOURABAYA, ETC.,—*By W. Chimmo, Lieutenant, R.N.*

Early in the morning of the 3rd of September, 1856, we left our anchorage off the mouth of the Victoria, to ensure having high water on the Flat with the highest tide, (the third after the change,) with which I concluded we should go over any part of it; but off Observation Island we unfortunately grounded immovably. The tide had fallen three feet in a few minutes; but we had shored her and prevented her falling over. We watched the tide falling foot by foot until it left her keel seven feet above low water mark. Indeed it seemed as if there would not be sufficient to float her off until the following springs. The *Torch* had never been on shore before in the course of this voyage, and we had the poor consolation of knowing that this bank had accumulated, since Capt. Stokes' visit and survey, from a *quarter fathom* below the level of low water spring tides to *seven feet* above it.

Every proper measure was adopted for her safety, and we waited patiently for the tide to rise, counting the minutes and watching its progress from the time it commenced to flow, which was at 6h. p.m. It rose twelve feet in two hours, when the ship rose from her bed and off she went, and we soon let go the anchor in seven fathoms to wait for daylight.

The bearings of this new portion of Australia are:—Indian Head, S. 25° E.; River Peak, S. 49° E., nearly on with South extreme of Observatory Island; North extreme of Observatory Island, S. 68° E.; Dome, S. 83° E.; left extreme of same range, N. 70° E.; right extreme of high land, S. 23° W., two hillocks. Ship's head, N.W. Deviation, 6° 30′ W. Variation of the compass, 1° 14′ easterly.